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# LOGGING TO SAVE PONDEROSA PINE REGENERATION: A CASE STUDY

*by*

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## *ABSTRACT*

Marking understory crop trees before logging a 24,000-board feet-per-acre stand of mature ponderosa pine resulted in preserving 180 crop trees per acre over three-fourths of the area. Falling caused more damage to prospective crop trees than skidding. Three-stage logging on flat ground did not seem necessary in this test. A front-end grapple did less damage to residual crop trees in piling slash than a conventional crawler tractor with slash blade, but the tractor piled more of the smaller material. Following the procedure demonstrated in this case study would cost a little less than clear-cutting and planting, using present-day expenses in central Oregon.

KEYWORDS: Regeneration methods -)economic evaluation, ponderosa pine, *Pinus ponderosa*, logging (-regeneration, understory layer.

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Ponderosa pine (*Pinus ponderosa*) harvesting in the Pacific Northwest may be broadly grouped into four systems--clearcutting, seed tree, selection, and shelterwood. Under the latter three, an attempt is made to preserve younger trees in the stand. Clearcutting, on the other hand, means that the understory trees, if present, will be destroyed and the area replanted. Where young trees are badly diseased, clearcutting is usually the only alternative, although occasionally seed tree or shelterwood may be used if the overstory is quickly removed after the regeneration is established.

In a healthy stand where overstory volume is light, forest managers generally try to harvest the merchantable trees and save the understory. However, where stands contain a heavy overstory volume (20,000 board feet or more per acre), managers often differ in their prescription for the area. One manager may choose to clearcut, while another prefers to carefully remove the overstory and save a portion of the understory. Such choices apparently stem from good and bad experiences in logging. Where heavy volumes occur in central Oregon, some attempts to save an adequate number of understory trees have been discouraging.

There are several million acres of ponderosa pine land in the Pacific Northwest where the incentive to save the understory is great, where preserving trees from 1 to 8 inches in diameter and 6 to 30 feet in height would be equivalent to 10- to 30-year-old planted trees. If enough trees could be saved to adequately stock the area, the job of site preparation and planting could be eliminated; and some saving in maturity time is possible. Furthermore, the area would be stocked with well-established trees highly adapted to the site through many generations of natural selection. Also, the land is kept green, and the objectionable denuded appearance that results from clearcutting and planting is avoided.

The western forest manager has been concerned for decades about saving residual understory trees. Considerable success in reducing damage to residual trees was achieved from 1950 to 1960 (Hallin 1959, Cosens 1952). Smaller, more maneuverable yarding equipment and a detailed logging plan were emphasized. In addition, stage cutting and skid trail, road, and land location were recognized as worthwhile steps for the orderly removal of timber.

A lot of eyeball and some detailed (Foiles 1962) appraisals of residual stand condition after logging have been based on damage or reduced stocking rather than how many crop trees per acre were left. In logging seed trees from a regenerated area, McDonald (1969) set up a stocking standard and then designed a harvest procedure to keep this desired stocking. Rather than appraise damage in the study reported here,[1/] we chose to set a partial stocking standard by marking leave trees and instructing the logger to avoid the marked trees; i.e., damage was not studied but stocking of usable trees was.

This note presents results of logging a 40-acre[2/] stand of mature ponderosa pine where understory saplings and poles were marked to save. All phases of logging and slash disposal were monitored to identify stocking changes associated with each operation.

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[1/] A cooperative effort between the Deschutes National Forest and the Pacific Northwest Forest and Range Experiment Station.

[2/] One acre equals 0.4 of a hectare.

Experience has shown that good communication between a timber purchaser and the Forest Service is essential for a good job of logging. In view of this, a prelogging conference was held in the woods with representatives of the purchaser, Gilchrist Timber Co. of Gilchrist, Oregon, Deschutes National Forest Timber sale administrators, and the Pacific Northwest Forest and Range Experiment Station. Objectives of the study were jointly discussed by the sale administrator and the timber company before logging began, and instructions given to fallers and skidders by company supervisors. Communication between company supervisors, workers, and sale administrators was maintained daily throughout the logging operation.

## THE STUDY

### *Objective*

Keep in mind that this was an exploratory trial in preserving understory trees by the "mark leave tree method." In addition, we wished to compare the option of two- versus three-stage logging and to identify the logging process most damaging to marked trees. Since fuel buildup in our public lands is of prime concern in preventing catastrophic fires, we also wished to compare two methods of heavy fuel disposal.

The study was done on the Pringle Falls Experimental Forest, 35 miles southwest of Bend, Oregon. Logging was done during the spring of 1973.

### *Stand Characteristics*

Before logging in 1973, the two-storied stand contained evenly distributed, mature and overmature ponderosa and lodgepole pine (*Pinus contorta*) in the overstory, with a heavily stocked, suppressed understory of the same two species (fig. 1). Gross standing volume of

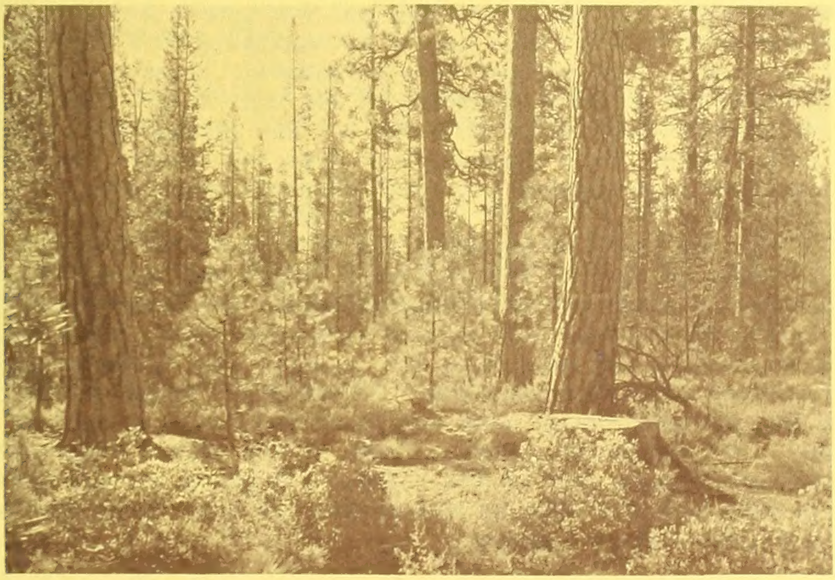

*Figure 1.--Before logging ponderosa pine with understory of saplings. The old skid trail in the foreground was established during a light sanitation cut early in the 1950's. Such trails were utilized in completely removing the overstory in this study.*

merchantable trees was 24,000 board feet per acre. Lodgepole pine constituted only about 1 percent of total volume. About 4,000 board feet per acre had been removed in the late 1950's and 1960's. The average merchantable lodgepole tree was 14 inches[3] in diameter and contained 2.3 16-foot[4] logs. The average ponderosa pine tree was much larger, being 28 inches in diameter and 4.3 logs long.

Just before the 1973 harvest, understory density averaged about 5,000 stems per acre. A few lightly stocked areas of understory could be found where overstory density was high. Understory trees were mostly sapling-sized trees 1-5 inches in diameter and 4 to 20 feet in height. Although this suppressed ponderosa pine understory ranged in age from 50 to 80 years, a previous study showed that such trees would respond remarkably well to release (Barrett 1973). Small lodgepole pine poles, with poor crowns and infected with dwarf mistletoe and western gall rust, were scattered throughout the stand.

Antelope bitterbrush (*Purshia tridentata*) was the predominant ground vegetation, although snowbrush ceanothus (*Ceanothus velutinus*) and pine manzanita (*Arctostaphylos parryana* var. *pinetorum*) were present. This brush did not hinder the logging.

Topography was predominantly flat, with a gentle slope on one side.

### *Methods*

Before logging, on an average, 74 understory sapling-sized leave trees per acre (24- x 24-foot average spacing) were marked with paint as crop trees to be avoided by the logger. Trees were marked at a spacing that seemed reasonable at the time for maneuvering of skidding equipment between trees. Observation of other logging has shown that trees tend to be left in thickets and that single trees in openings are destroyed. We reasoned that, by marking the leave trees, we would end up with a systematic pattern throughout the stand. A final stocking of 180 trees per acre (15.5-foot spacing) was our goal. Thirty-eight 0.4-acre circular sample plots were spaced mechanically on a 200-foot grid over the 40 acres. Plot centers were permanently located with a steel rod driven into the ground. Location of all understory crop trees and marked overstory harvest trees on each plot was plotted with a transit equiped with stadia. This enabled us to find and observe each marked leave tree after each logging and slash disposal operation.

All overstory trees to be harvested were marked with paint before the sale. Trees on half of the area were felled and skidded in two stages and on the other half, in three stages. Overstory trees to be removed in the first stage were marked with blue paint, and these trees were felled towards and away from the landing, thus minimizing the need for turning logs when skidding. In the first stage, trees that would do the greatest damage were cut, such as heavy leaners and those with large limbs and heavy crowns. Trees in the second stage were marked with white paint and in the third, with green paint. Approximately one-half and one-third of the volume was removed in each stage of two- and three- stage logging.

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[3] One inch equals 2.5 centimeters.

[4] One foot equals 0.3 of a meter.

After logging and before slash disposal, additional understory trees were marked, bringing the average number of residual trees per acre up to 106 (20- x 20-foot spacing). This gave us a new, more realistic spacing of trees on which to judge crop tree loss resulting from slash disposal. Logging slash on half of the area was piled with a conventional, crawler-type tractor and brush blade and on the other half, with a grapple-type, front-end loader. The east half was logged in three stages; the west half, in two stages. Slash on the north half was piled with a tractor and on the south half, with a grapple. Treatment areas were chosen by flipping a coin. Log landings, by chance, fell outside all 0.4-acre plots.

After slash burning, a stocking survey on a 1-chain[5/] grid was made. A grid point was considered stocked if a tree was present that was at least 12 inches high and of good thrift. Although there were very few trees as small as 12 inches, we selected this minimum standard because it would be equivalent to a 3-0 planted tree. A stocking standard of 180 trees per acre was established as a possible goal for the area. If a tree was found in a circle representing the area occupied by one tree in a 180-tree-per-acre stand, the grid point was considered stocked for the density goal. This density standard was used because on the Deschutes National Forest about 180 trees per acre are left in many precommercial thinnings.

Since treatments were not replicated, statistical analysis could not be done. Further study will be replicated over a range of geographical conditions to make results broadly applicable.

### *Logging*

Fallers were instructed to fall first-stage trees either toward or away from landings, but they selected direction of tree fall in the second and third stages. No skid trails were marked and tractor operators were instructed to use their skill in avoiding marked leave trees. Skidding was done with a crawler-type tractor and rear-mounted hydraulic grapple tongs. Since an arch and chokers were not involved, tractor maneuverability was good.

The area was bounded on two sides by National Forest system roads and divided by a spur road. Logs were loaded from landings at the edge of roads.

Damage to marked leave trees was monitored after each of the following operations: first-stage falling, first-stage skidding, second-stage falling, second-stage skidding, third-stage falling, third-stage skidding, slash piling, and slash burning.

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[5/] One chain equals 20.1 meters.

# RESULTS

*Logging*

Almost 20 percent of the understory trees originally marked were lost in logging when data from all 30 plots were averaged (fig. 2). Of this loss, 66 percent was due to falling and 34 percent, to skidding. Most falling damage to residual saplings and pole-sized trees consisted of top break. Where only the current year's height growth was broken, the tree was tallied as a usable crop tree. A break lower on the bole was tallied as a tree loss.

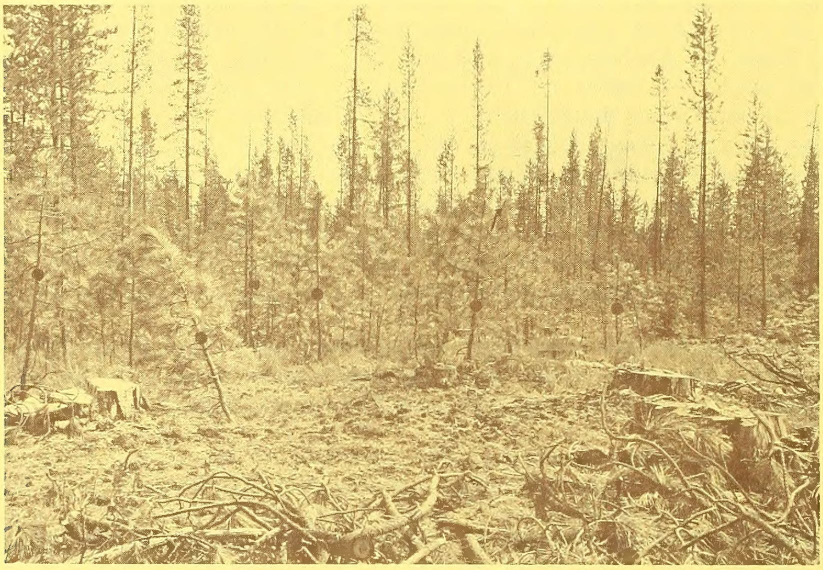

*Figure 2.--After logging the stand shown in figure 1. Trees with black dots are leave trees marked as part of the 74 trees per acre originally marked. Badly bent tree would be considered a loss.*

When the data are separated into plots where two-stage logging (21 plots) and three-stage logging (17 plots) were applied, averages indicate a slight advantage to three-stage logging (table 1). Skidding losses for two-stage logging averaged slightly more than 1 1/2 times that for three stages. Greatest losses from two- and three-stage falling occurred during the second stage. Heaviest losses from skidding (figs. 3, 4, and 5) in three-stage logging occurred in the first stage and gradually diminished through the third stage. In two-stage logging, heaviest skidding losses also occurred in the first stage.

An average of 75 pieces per acre was skidded from the area. Pieces ranged from 10 to 32 feet long.

Table 1--*Percent of the original number of marked trees lost in falling and skidding in two- and three-stage logging*

| System | First stage | | Second stage | | Third stage | | Total all stages | | Fall + skid |
|---|---|---|---|---|---|---|---|---|---|
| | Falling | Skidding | Falling | Skidding | Falling | Skidding | Falling | Skidding | |
| | *Percent* | | | | | | | | |
| Two-stage (68)[1] | 6.1 | 6.3 | 6.9 | 1.6 | -- | -- | 13.0 | 7.9 | 20.9 |
| Three-stage (79)[1] | 4.3 | 2.8 | 6.1 | 1.5 | 2.8 | 0.35 | 13.2 | 4.7 | 17.9 |

[1] Average number of understory leave trees per acre initially marked in stands logged in 2 and 3 stages.

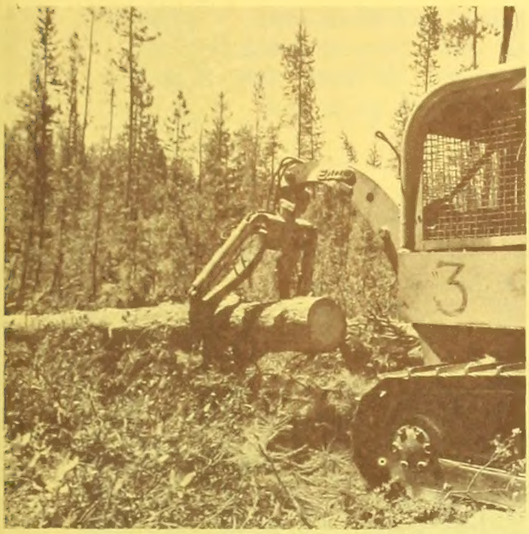

*Figure 3.--Thirty-two-foot log being carefully removed from an area of marked leave trees.*

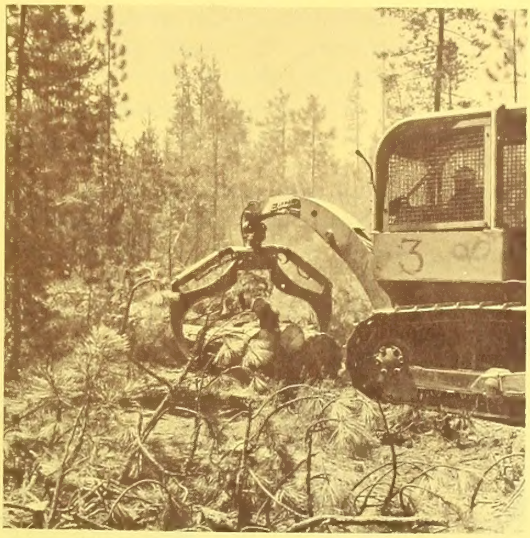

*Figure 4.--Log bunching areas were usually located along main skid trails.*

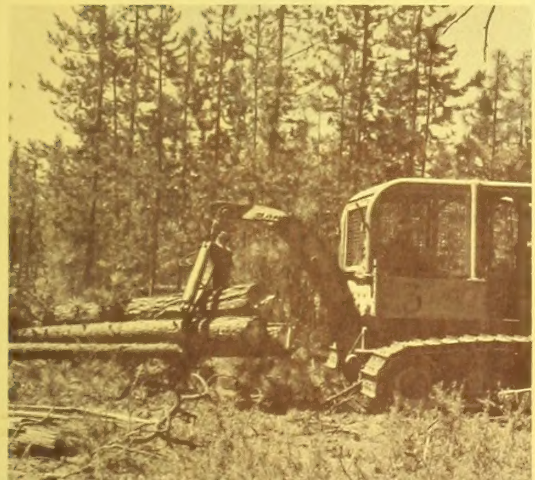

*Figure 5.--Even though this appears to be a large turn of logs to manipulate between trees, skidding caused only about one-third of the logging damage.*

*Slash Disposal*

As mentioned, additional crop trees were marked after logging to provide a reasonable tree density for comparing two methods of piling slash.

Over the total area, only about 6 percent of 106 crop trees per acre were lost to piling and only 1 percent to burning. Greater damage was done by the crawler-type tractor with a conventional brush blade (figs. 6 and 7) than by the front-end grapple. About a 9-percent loss was observed on cat-treated plots compared with 3 percent for the grapple (figs. 8, 9, and 10). Both machines were required to pile approximately 70 percent of material down to 4 inches in diameter and 6 feet long, plus pieces 10 feet or more in length regardless of diameter. The grapple piled only this much because smaller material fell through the forks of the front-end grapple (fig. 11). The tractor, on the other hand, piled much more smaller material simply because it was in the path of the brush blade.

Slash piles were placed in nonstocked holes in the stand that were 30-35 feet in diameter. If there was room, a fireline was cleared around the pile. Piles were approximately 15 feet in diameter and 10 feet high. About 8 percent of the total land area was used for the slash pile and for tractor-maneuvering room around the pile.

A survey after slash burning showed that if our stocking goal of 180 trees per acre was met, the area would be 75-percent stocked with trees averaging about 3 inches in diameter and 12 feet high. The 11 log landings included in the stocking survey covered about 1.3 acres, or 3 percent of the logged area.

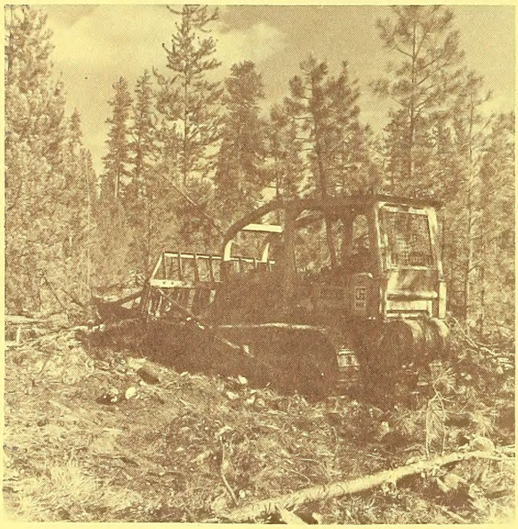

*Figure 6.--Slash tractor working heavy fuels out so material may be burned.*

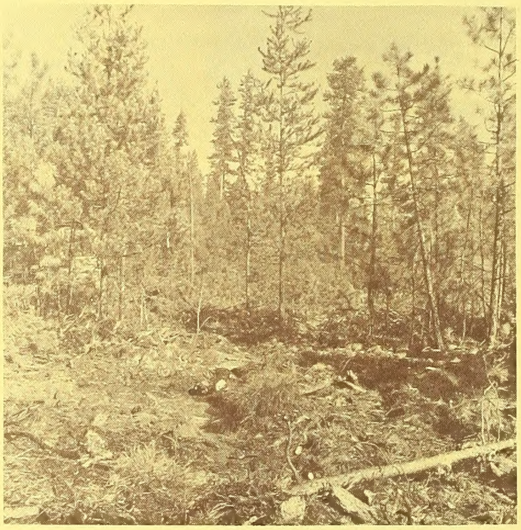

*Figure 7.--Only lighter fuels remain after pass with slash tractor.*

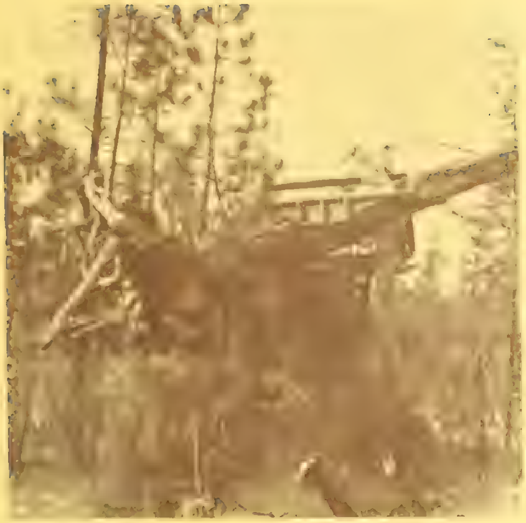

*Figure 8.--Front-end grapple picking a chunk of "hot" fuel from a reproduction thicket.*

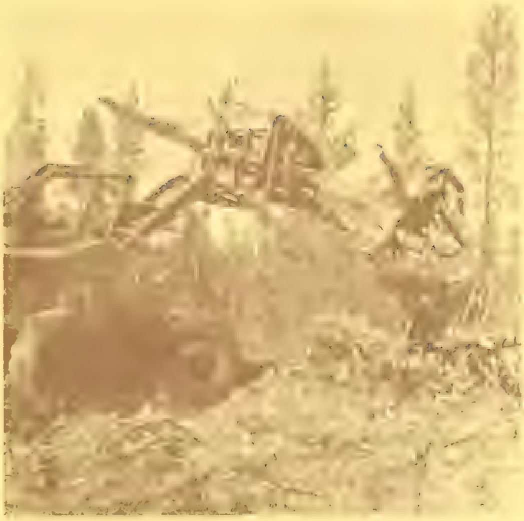

*Figure 9.--Large pieces may be transported to the pile at a height that will not damage sapling reproduction.*

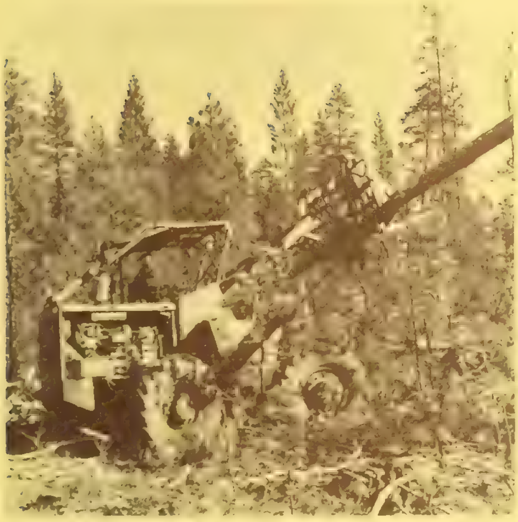

*Figure 10.--Slash this long is difficult to move to the slash pile and should be bucked before being picked up.*

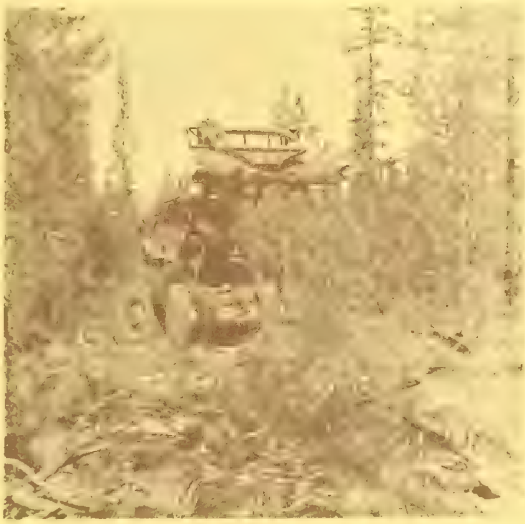

*Figure 11.--Small pieces of slash fall through the forks of the front-end grapple.*

# DISCUSSION

## *Tree Stocking*

In this study, we were able to preserve 180 trees on 75 percent of the area. There are nonstocked areas in the stand where slash was piled, skid trails converged, and logs were loaded. The remaining sapling stand now needs to be thinned and the thinning slash crushed (Dell and Ward 1969). The thinner will leave the necessary number of trees in addition to those marked to bring tree density up to the desired level.

There is a question as to the necessity for planting about 15 trees per acre to fill in nonstocked holes where slash was piled and burned. Also, most managers agree that planting landings and major skid trails is not worth the effort, as they will be used again in the first commercial harvest.

## *Slash Disposal*

Currently, some managers are reluctant to cut a 20,000-board foot-per-acre stand in two or three stages in one sale because they feel the large amounts of slash cannot be piled without losing a large number of crop trees. A stand of 24,000 board feet is sometimes cut in three different sales of 8,000 each, cleaning up the logging slash each time.

Marking separate sales may not be necessary. In this sale, all slash from 24,000 board feet was piled and burned without losing more than about 6 percent of the marked crop trees. Furthermore, enough additional trees were spared that a total stocking of at least 180 trees per acre were left over three-fourths of the area. This and other experience on the Deschutes National Forest also suggest that the slash from 24,000 board feet can be disposed of for considerably less money when cut in one sale than in three separate sales.

## *Stage Logging*

Three-stage logging did not appear to be worth the effort in this trial, although a small difference in favor of three stages over two stages was found.

Since trees marked in the first stage were those likely to do the most damage, it is difficult to explain why second-stage falling damage was greater than the first. We had intended to have second-stage trees felled into beds created by trees felled in the first stage. Fallers, however, often resisted this because it meant working in slash created in the first stage. Also, there is a limit to how far a tree may be pulled. Some sale administrators believe that the skill involved in the first-stage tree selection and falling determines how much damage will be done in succeeding stages.

## *Method Improvement*

Observation of tractors working their way through marked trees indicates that more than 70 trees per acre could be marked. This in turn would restrict skidding somewhat but might improve stocking. Obviously we could mark too many trees and set up an unreasonable situation for the logger. It doesn't appear necessary to mark as many trees as the stocking goal. For example, if we mark 150 trees and achieve 75 percent of a goal of 180 crop trees per acre, we could require the thinner to leave enough additional trees without spacing some trees closer than 10 feet.

Systematic location of skid trails would probably promote a more orderly removal of logs. The trails could be located before logging when there is adequate time to consider timber and landing location and topography. This practice would reduce the number of skidder decisions and thus increase efficiency and skill in manipulating logs into the marked trail.

Losses in falling appeared to set the stage for skidding patterns in some instances. For example, when the tractor operator found a damaged marked tree, he sometimes used that as an avenue in the stand through which to proceed. If this happens often, it could lead to poor stocking distribution. The logger should avoid these damaged marked trees and thus preserve surrounding trees.

Great care should be used in marking trees to be cut in the first stage. Possibly less volume should be cut in the first stage. Skidding patterns could be established for orderly removal of the next stage.

The front-end grapple shows some promise in piling where an understory is to be saved. However, some improvements in the design of the grapple are necessary to keep large, short pieces from dropping through the forks.

As a further cost reduction in slash treatment, the option of broadcast prescribed burning without piling needs to be explored.

### *Economic Considerations*

Forest managers usually consider two alternatives for regenerating a mature ponderosa pine stand with a heavy volume and a sapling understory in central Oregon. One is to clearcut, prepare the site, and plant. The other is to save enough selected trees in the understory by careful logging to adequately stock the site. Elements of expense in the save-the-understory method that do not occur in clearcutting are: marking crop trees, additional cost of falling and skidding care, thinning, and crushing thinning slash. Following the procedure demonstrated here, saving the understory would cost a little less than planting, using present-day expenses in central Oregon.

A direct result of saving the understory is that commercial harvests from the next crop of timber will be realized approximately 15 years sooner than if the site was regenerated by planting after a clearcut. Although there appear to be obvious advantages to harvesting the next crop of timber 15 years sooner, the additional wood does not account for much of an economic gain when discounted to present value at currently acceptable interest rates. The roughly 12-percent growth increase may, however, increase the rate of old-growth harvest through the allowable cut effect (Schweitzer et al. 1972). A much greater economic impact can be realized by reducing regeneration costs, since these costs represent an immediate outlay of capital that is not discounted.

Using the understory and thus keeping the site "green" is a benefit that is difficult to evaluate in monetary terms, yet it is important to a significant portion of our society. Also difficult to measure is the value received from regenerating a site with trees that may represent thousands of years of natural selection. Perhaps the most important point to consider is the "bird in hand" concept. There is no absolute guarantee of regenerating a stand following clearcutting; but with the save-the-understory method, the trees are already there.

### *Application*

In applying these results, it should be kept in mind that this is a case study carried out on an Experimental Forest, with a given stand condition, and a cooperative timber purchaser. However, other major timber purchasers on the Deschutes National Forest are demonstrating their ability to do quality work in overstory removal logging. Some caution should be taken in applying these results to other areas and purchasers. Hopefully, forest managers will be encouraged to try overstory removal logging, rather than to clearcut, where overstory volume is heavy as well as where it is light.

### *What's Next?*

This method of marking the understory needs testing in areas large enough so that marking versus not marking can be compared and a statistically sound inference made. Although this trial did not lend itself to statistical tests, it does suggest what aspects should be incorporated into a series of trials throughout central Oregon. We propose to locate eight 40-acre tracts that are uniform enough so that half of the tract can be marked and half left unmarked. These trials would be carried out over several years so that variation in weather, purchaser, terrain, and stand characteristics would be sampled. In addition, costs and benefits of three alternatives--marking understory, not marking, and clearcutting and planting--could be fully studied. Persons interested in cooperating in such trials on lands under their management should contact the U.S. Forest Service Silviculture Laboratory, 1027 N.W. Trenton Ave., Bend, Oregon 97701.

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